

# **The Solid State Energy Conversion Alliance**



## **Fuel Cells for Buildings and Stationary Applications Roadmap Workshop**

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# National Benefits



## Energy Security

- Multi-fuel capability allows use of available fuels or currently cost-effective fuels including hydrogen and coal.
- In many applications doubles the efficiency of producing power from fossil fuels compared to current technologies.
  - Reduced CO<sub>2</sub> emissions
  - Reduced dependence on imported fuels
- Rapid response to local energy shortages. Eliminates long-lead time and economic uncertainty.





# National Benefits



## Environment and Health Benefits

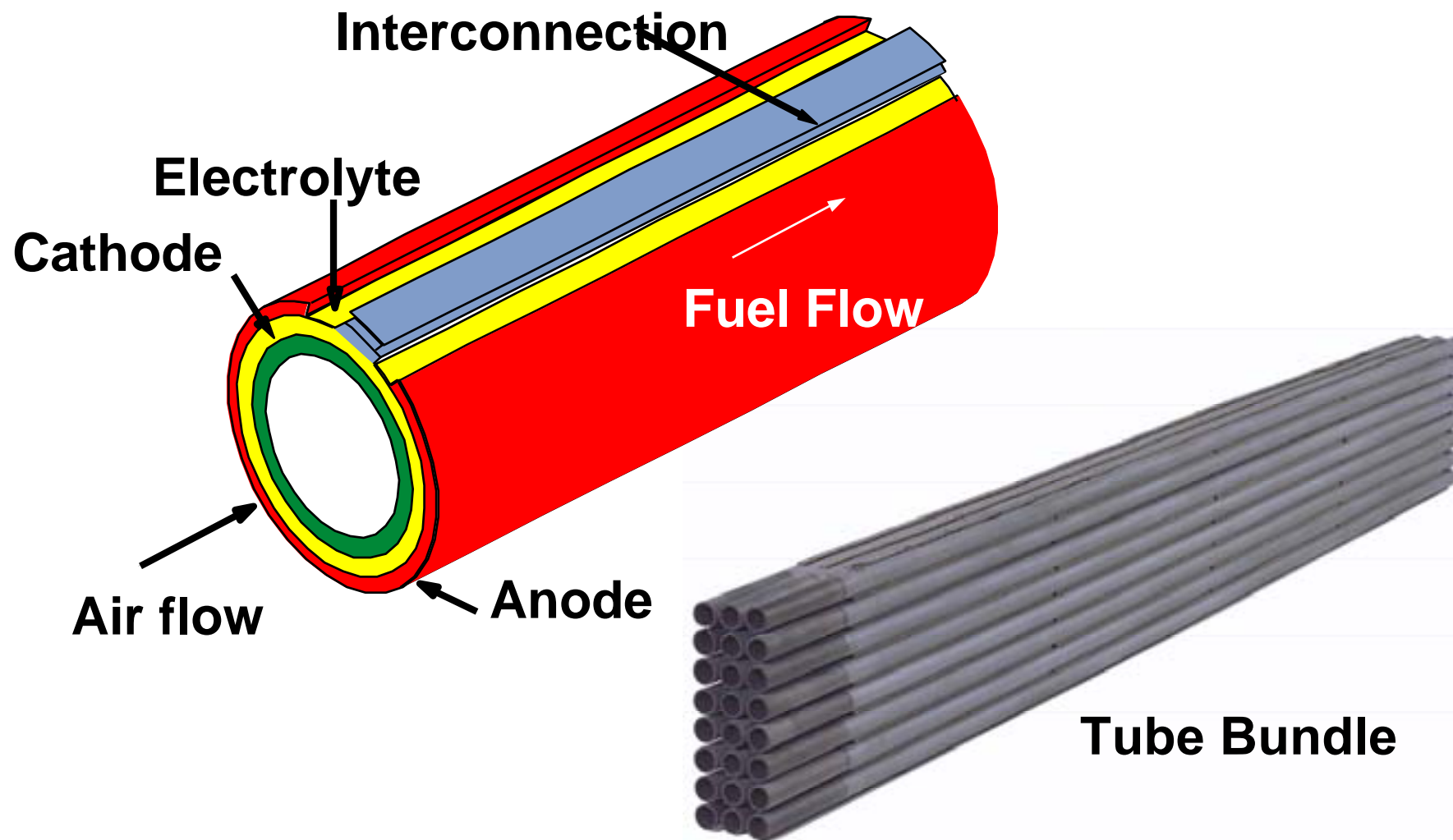
- Important health benefits due to the negligible emission of environmental pollutants using fossil fuels.

## Economic Choices

- Provides a grid independent, environmentally friendly power source for use in the undisturbed, natural areas of the nation.
- Provides more power choices for residences and businesses. The high efficiencies of a combined heat and power (CHP) system along with a choice of fuel, power quality, grid integration or grid independence will provide citizens with choices and will significantly assist de-regulation efforts throughout the nation.



# Tubular SOFC



# Tubular Solid Oxide Fuel Cells



**2001**

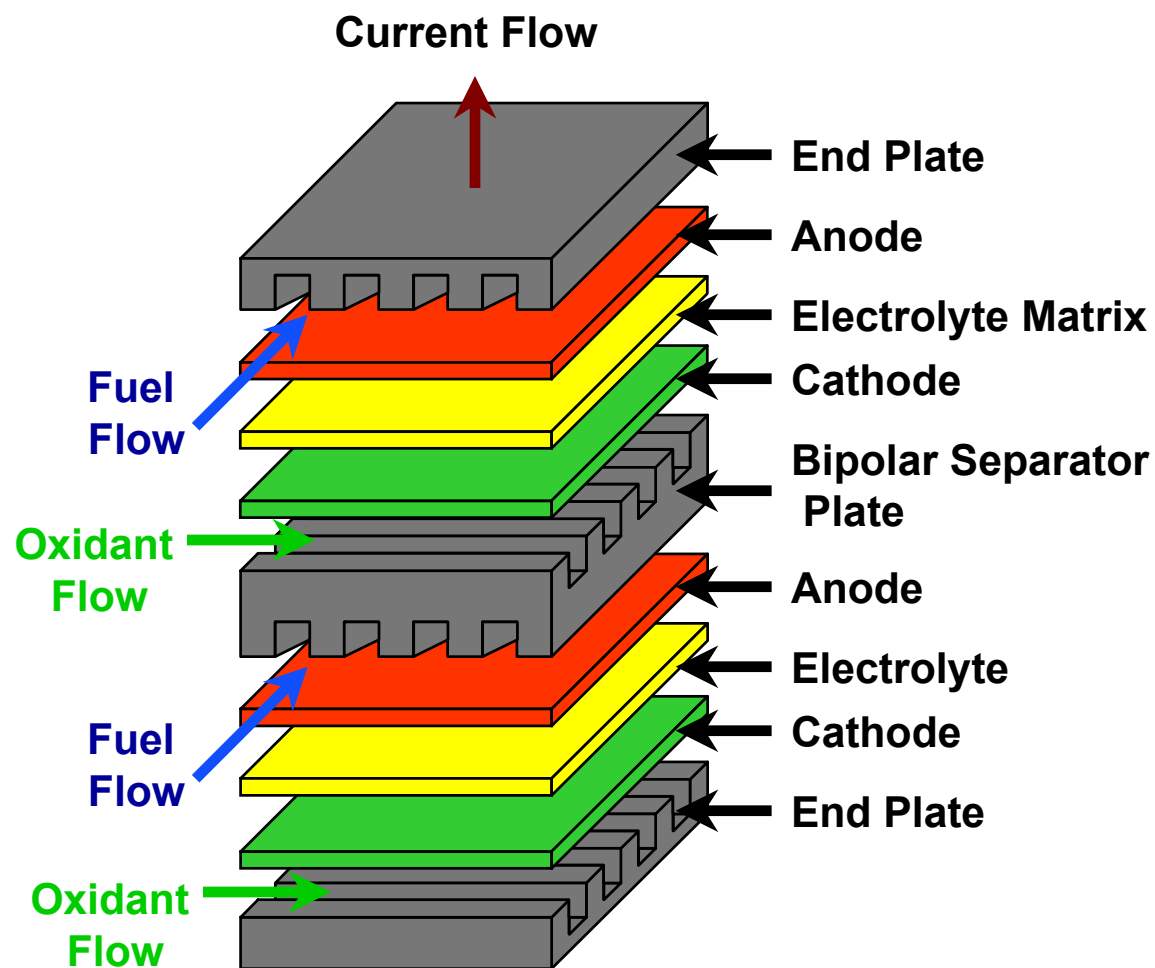
- 47% efficiency
- > \$10,000/kW
- 100-220kW
- 16,000 hr operation at 100-kW

**2003-2008**

- Near-term DG market
- 47- 63% efficiency
- Homestead, PA 15MW/yr Manufacturing facility 2003 (\$4500/kW initially)
- 250kW - 550kW
- \$1,000-1,500/kW



# Planar Cell



# Automotive Auxillary Power Unit



**DELPHI**

*Automotive Systems*



SECA 032901

*Strategic Center for Natural Gas*

# FCT 5 kWe SOFC Power System Oblique View-Open Access Panels



SECA 032901

*Strategic Center for Natural Gas*

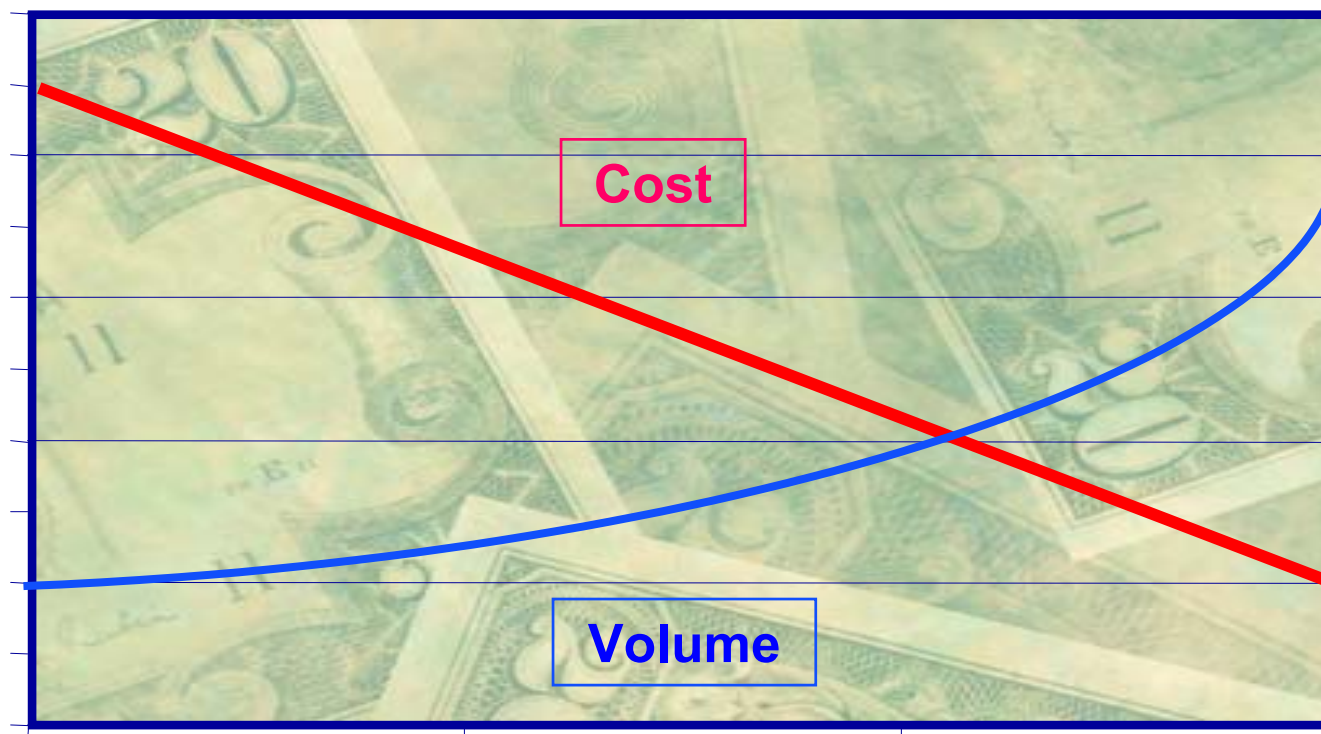
# Working Definition of Hybrid Fuel Cell



- A combined-cycle power generation system containing a high-temperature fuel cell plus a
  - ✓ Gas turbine  
*or*
  - ✓ Reciprocating engine  
*or*
  - ✓ Another fuel cell



# The Vision: *Fuel Cells in 2010*



**Low Cost/High Volume**  
**\$400/kW/ > 50,000 units/yr**





## SOFC Materials Costs

SOFC Component	Material Cost (\$/kW)
<i>Common Materials (excluding interconnects)</i>	
Ni/ZrO <sub>2</sub> anode (500 microns)	11.67
ZrO <sub>2</sub> /Y <sub>2</sub> O <sub>3</sub> electrolyte (10 microns)	0.40
LaMnO <sub>3</sub> cathode (50 microns)	2.30
ss End Plates (1.25 centimeters)	0.70
<i>Subtotal Common Materials</i>	<i>15.07</i>
Ceramic Interconnect (2.5 millimeters)	137.50
<i>Subtotal Ceramic Interconnect &amp; Common Materials</i>	<i>152.57</i>
50% Contingency	76.28
<b>Total Material Costs Using Ceramic Interconnects</b>	<b>228.85</b>
Metallic Interconnect (2.5 millimeters)	6.67
<i>Subtotal Metallic Interconnect &amp; Common Materials</i>	<i>21.74</i>
50% Contingency	10.87
<b>Total Material Costs Using Metallic Interconnects</b>	<b>32.61</b>

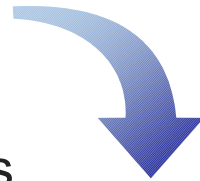


# SECA Goals and Applications



**2005**

- **\$800/kW**
  - Long-haul trucks
  - RVs
  - Military
  - Premium power



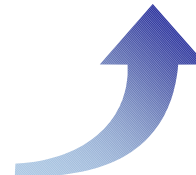
**2010**

- **\$400/kW**
  - Residential & industrial CHP
  - Transportation auxiliary power



**2015**

- **Vision 21 power plants**
  - 75% efficient
- **Hybrid systems**
  - 60–70% efficient





## Technical Requirements

<b>Cost</b>	<b>\$400 / kW</b>
<b>Power Rating Net</b>	<b>3-10 kW</b>
<b>Efficiency (AC or DC/LHV)</b>	<b>30 - 50% [APU] 40 - 60% [Stationary]</b>
<b>Fuels (Current infrastructure)</b>	<b>Natural Gas Gasoline Diesel</b>
<b>Design Lifetime</b>	<b>5,000 Hours [APU] 40,000 Hours [Stationary]</b>
<b>Maintenance Interval</b>	<b>&gt; 1,000 Hours</b>



# Program Structure



Industry Input



Program Management



Project Management

*Needs*

*Research Topics*



Industry Integration Teams

	University	National Lab	Industry	Small Business	
Fuel Processing					→
Manufacturing					→
Controls & Diagnostics					→
Power Electronics					→
Modeling & Simulation					→
Materials					→

Fuel Cell  
Core  
Technology

*Technology Transfer*

Core Technology Program



## INDUSTRIAL TEAMS



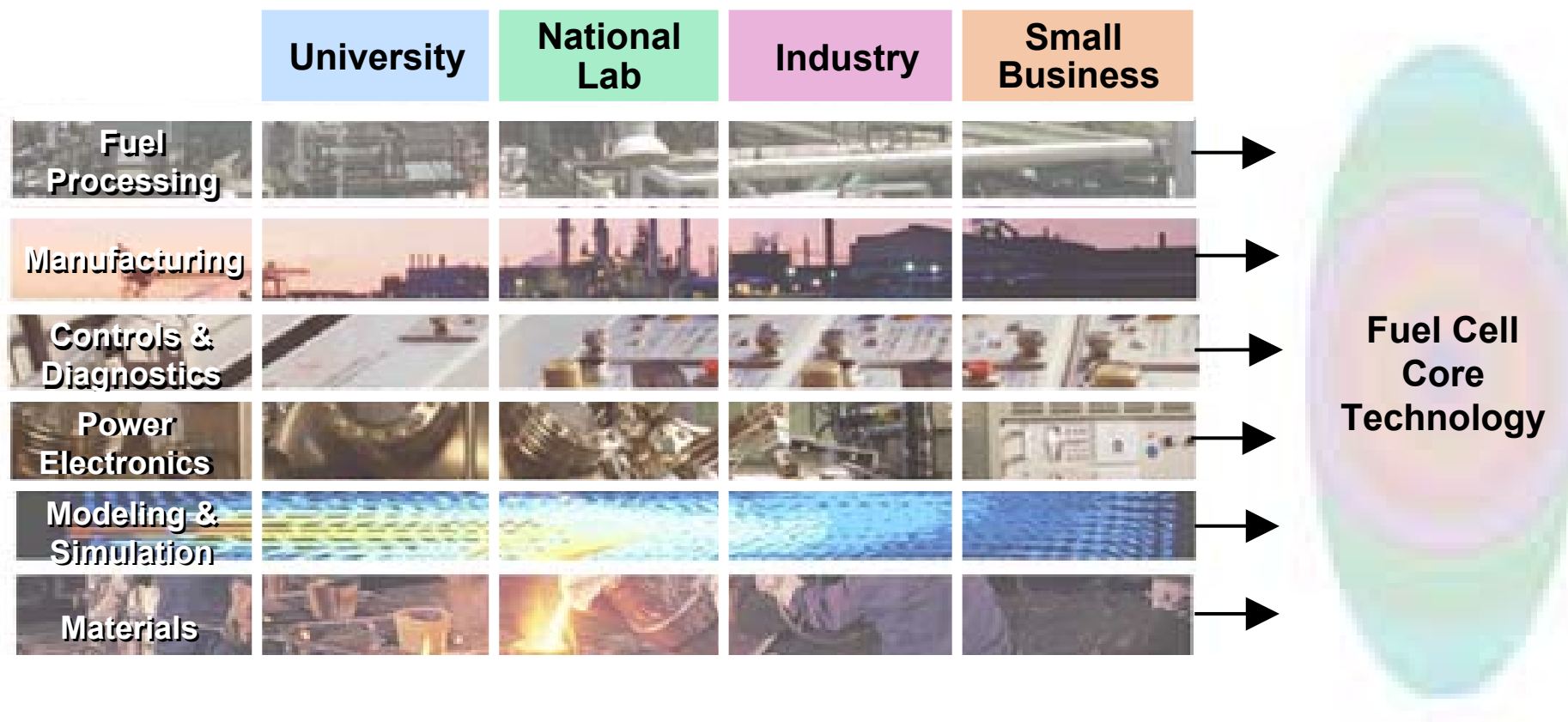
<b>Honeywell (GE)</b>	<b>Demonstrated a unique unitized sealess radial design. Single cell performance at 700 C is near Goals</b>
<b>Delphi/ Battelle</b>	<b>Demonstrated automotive APU. Design developed by Battelle will use unique seals, anode, and cathode.</b>
<b>Cummins/ McDermott</b>	<b>McDermott has demonstrated a unique design and cost effective multi-layer manufacturing using techniques developed in the semi-conductor industry.</b>
<b>Siemens- Westinghouse</b>	<b>Siemens-Westinghouse has redesigned their technically successful tubular design to reduce stack cost.</b>





# Core Technology Program

## *The Technology Base*



## Alliance



	# of Participants	Funding Mechanism
Large Business	5	Industrial Teams 1999 PRDA 2000 Multi-Layer
Small Business	6	2000 Multi-Layer SBIR Phases I & II
Universities & Non-Profits	6	1999 PRDA UCR
National Laboratories	6	Field Work Proposals

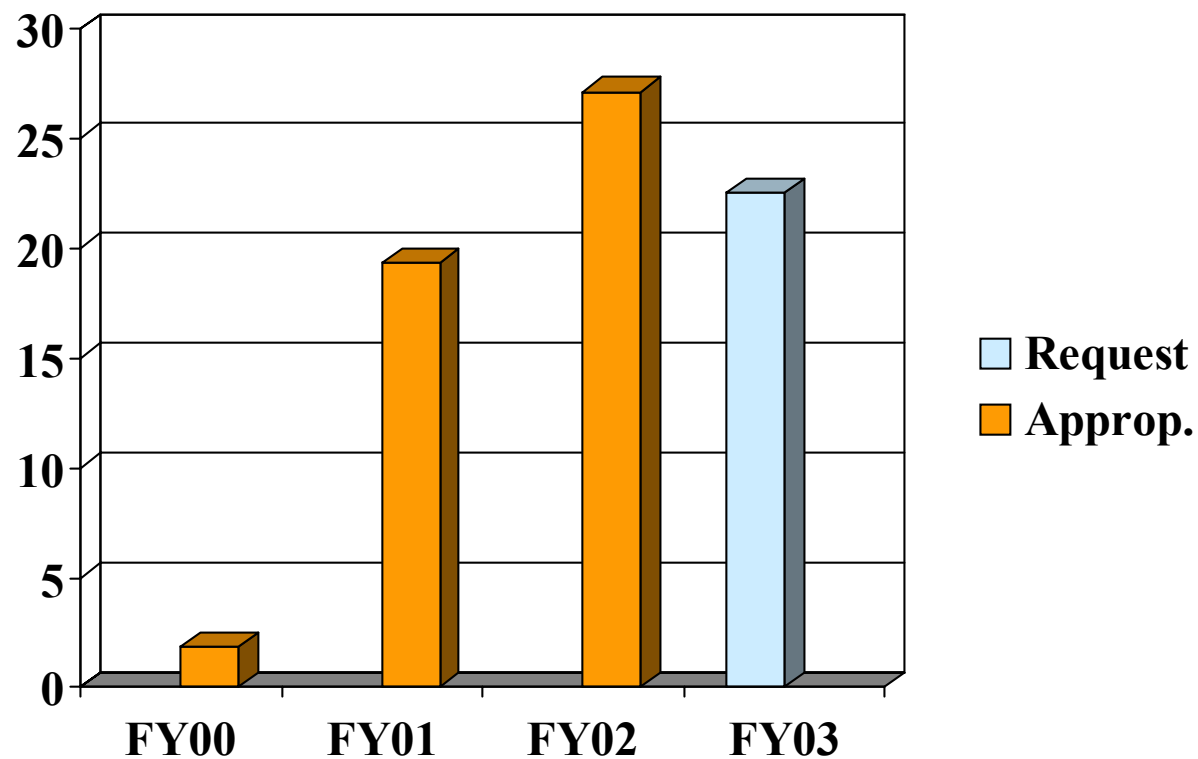


# SECA Players/Efforts

## *Universities, National Labs, Industry*



# SECA Budget (\$ - millions)



# SECA Timeline



- Industry Team Solicitation Issued November 3, 2000
- Proposals Due *January 3, 2003*
- SECA Core Technology Program Workshop February 14 & 15, 2000
- 2nd Annual SECA Workshop March 29 & 30, 2001
- 2001 Industrial Teams Selected August 2001
- Core Technology Program Review November 2001
- Core Technology Program Solicitation Issued January 2002
- Core Technology Program Review *June 18 & 19, 2002*

[www.netl.doe.gov/scng](http://www.netl.doe.gov/scng)  
[www.seca.doe.gov](http://www.seca.doe.gov)



## FUTURE NEEDS

